years, and specific stations are only removed after 2 years of receipt of a specific notice for that station. There is no incumbent compensation unless the entrant wishes earlier access. Some incumbents can remain indefinitely if there is no demand for the new service in that area. The policy is successful because most equipment in a band that requires renewal (upgrade or change in use) has been in place for many years and is fully amortized. The policy has been adjusted in particular circumstances.

The Commission should apply rules that recognize that equipment becomes obsolete and will be replaced. As part of the economic rent for spectrum, users should replace or remove equipment at their own cost after a reasonable period to either improve spectrum efficiency or permit entry of more desirable services. Current policies encourage operators to keep systems on the air that are no longer useful in order to maintain the assignment, provide a third level back-up, or preserve the chance of future compensation. In the PCS auctions, the compensation policy may have unfairly benefited those bidders who owned incumbent systems, as it increased the costs of other would-be entrants who did not.

The Commission's policy of compensation of incumbents to permit new entrants is antithetical to flexible and economical use of the spectrum. It encourages warehousing in bands that may be subject to change, it increases costs for users, effectively bestows a property right and provides unearned windfalls. Annex 4 provides a different perspective on this matter.

18. Do any existing Commission rules inhibit efficient use of the spectrum? If so, how should they be changed?

The current band-clearing policy promotes inefficiencies by encouraging incumbents to maintain existing systems if there is a prospect of compensation. This slows and halts the rollout of new services in marginal-revenue areas as the incoming entity uses his reduced capital

resources in high revenue areas. It increases the cost of service to those who have it and denies it to those who should have it. This is a case where the policy serves process but the product suffers. Auction costs amplify these problems.

Rules defining the use of the spectrum lead to inefficiencies when it divides the spectrum into type of user rather than type of use. This yields uneven exploitation of bands even for the same type of use in the same region of the spectrum, since one group uses spectrum more effectively or faster than another does.

In a larger sense, this also applies to government/non-government bands. See Annex 3. This particular division complicates global market compatibility, and domestic flexibility.

19. What new technologies exist that, if deployed, could improve spectral efficiencies and utilization? What are the barriers to their deployment?

Fiber optics is inarguably the most efficient transmission technology. A policy to encourage fiber optic replacement of point-to-point or multipoint radio technologies could eventually eliminate the need for radio in populated areas for other than mobile services. A realistic spectrum rent would make this choice easier for the operator and reduce congestion. Parenthetically, this would help the massively under-utilized fiber optic infrastructure, cause it to expand and extend, and may even help the overall telecom sector of the capital market.

20. Should the Commission consider ways to quantify or benchmark spectral efficiency in a way that permits fair and meaningful comparisons of different radio services, and if so, how would such comparisons be used in formulating spectrum policy?

a. How could the Commission define and quantify spectral efficiency?

b. *How could the Commission meaningfully compare efficiencies across different radio services?*

c. *Should spectrum efficiency be analyzed subjectively as opposed to quantitatively? If yes, how? To what extent should any rules, standards or guidelines regarding spectral efficiency take into account the relative scarcity of different uses and different geographic areas as well as the cost of spectrum-conserving technologies?*

d. *What data and other information is necessary for the Commission to evaluate spectral efficiency?*

Benchmarking is a good method to track improvements in technology. However, if comparison of spectral efficiencies would mean giving the most spectrum to the service with the greatest spectral efficiency, it would be a distortion of the needs of the different communities of users. Spectrum efficiency is a valid guide within a service, but otherwise it is figuratively apples and oranges. Spectrum efficiency could be measured in units such as bit/s/Hz/km^2, but would be meaningful only for a give type of product. Relating efficiency to the number of users would distort the relative value of services. It is also difficult to decide if it more efficient to provide one user 10 MB/s or ten users 1 MB/s, or to serve 100 customers in a 10 square kilometer area or a 10,000 square kilometer area.

21. *How, if at all, can the Commission provide incentives for operators to use spectrum efficiently? For example, how could to the implementation of fees (e.g., on the basis of Hz per square mile per minute or Hz per population coverage) or receiver standards affect spectrum efficiencies?*

The basic tool of the Commission is the license. If a reasonably efficient use of the spectrum is not achieved, the license might be revoked or not renewed, so a more efficient operator can use it. Spectrum efficiency as defined by bits/s/Hz gives a meaningful hardware standard to increase efficiency, whereas the suggested definitions are dealing with externalities unrelated to the performance of the radio system. They are no measure of the service actually taken up by the public. Spectrum rent will help measure beneficial use of the spectrum.

PUBLIC SAFETY COMMUNICATIONS

22. *What mechanisms can be developed to ensure the availability of dependable, interoperable and cost-efficient radio-based and other Communications services among local and state public safety and federal government agencies in their use of spectrum for public safety, law enforcement, homeland security, and critical infrastructure protection?*

Public safety users are generally not efficient users of the spectrum. They do not have access to the capital market to provide up to date equipment, nor are they in a competitive market that requires it. Radio takes a low priority in government budgeting processes. Growth in some public safety bands is low, and these bands could be shared in certain areas. A commercial entrant into one of these bands could offer to upgrade an existing system so both could use the band, the cost attributed to economic rent of the spectrum. Similarly, public safety system could use commercial bands, with the same policy of upgrade by a commercial entrant if blocked by a public safety user.

23. *Recognizing that many of these special needs for communications capacity are highly variable in time and location but generally low in average traffic level, should the Commission and these users consider novel sharing mechanisms for*

such spectrum that might be appropriate and what criteria (e.g., very high reliability) would need to be used to determine whether such sharing is advisable?

Public Safety should use commercial facilities if the cost is comparable, the system is equally reliable, and traffic priority is maintained.

24. How should the amount of spectrum dedicated for the support of public safety and related functions be determined?

In order to know how much is needed one needs to know how fast it is being used, how well it is used, and how much is left. In some bands, the FCC is in dire need of accurate databases and the means to manage them. Otherwise, forecasts are speculation.

INTERNATIONAL ISSUES

25. What role should international/global considerations play in spectrum policy in the United States? And conversely, how should U.S. preparations for regional and international meetings on spectrum policy take into account domestic spectrum policy decisions?

All business, political and economic trends are toward globalization, which means there are fewer and fewer opportunities or desires for independent domestic action. American companies are at a disadvantage if U.S. spectrum policies are too divergent from those of the rest of the world, which is rapidly becoming more aligned with European use. Domestic decisions should default to the international trend unless there are compelling reasons not to.

U.S. flexibility is constrained because the Government use of the spectrum is largely unique in the world. The Commission, NTIA, and State should undertake a task to determine a

transition scheme to bring U.S. spectrum more into line. This may involve studies to consolidate government use into fewer bands.

The U.S. must participate in international preparatory meetings and has had great success when it had a clear and logical domestic policy. However, it suffers in credibility and success when it seeks solutions that are only viable at home.

26. How should the requirements for international coordination of satellite systems affect the U.S. assignment of satellite orbits and frequencies for domestic and international service

The existing coordination queue process in the ITU is flawed because the long delays both benefit and encourage paper systems. Unimplemented systems far outnumber real ones. In contrast, the domestic FS successfully operates on a first-come, first-served basis and has few paper systems, since industry is able to almost immediately complete frequency coordination and government requires implementation within six months.

Like the FS, private coordination of satellite networks could shorten the delay. A properly formed international association of satellite operators could resolve many coordination conflicts between themselves at an accelerated pace. This process could be in parallel to the ITU process and not negate it. If the association used ITU approved tools and methodology, their results should be acceptable as definitive. If the association determined that a party is not negotiating in good faith, the network would remain in the ITU queue, but the association could inform the ITU of its "finding" on that system. Developing country domestic network operators could choose to participate or leave their system in the normal ITU process if they feel protected by the ITU process. All systems will achieve coordination more quickly as paper systems, which are often back-ups, and mostly from developed countries should drop out earlier.

This would be analogous to the highly successful Space Frequency Coordination Group operated by NASA and its sister organizations in other countries for the space science bands.

27. Does the International Telecommunications Union (ITU) spectrum allocation process, as codified in the ITU Radio Regulations, facilitate or impede development of domestic spectrum policies?

The ITU allocation process is more responsive than it has been, but it has little discipline in terms of controlling agendas and organizing preparatory work. This has resulted in extraordinary workloads, leading to a desire to hold fewer conferences. More discipline will yield better results. It is a vast improvement over the 20-year hiatus between 1959 and 1979, except that those two conferences globally reviewed allocations. In the current sequence of conferences, only certain bands are examined, resulting in more fragmented and restricted use of the spectrum.

An effort by the ITU Voluntary Group of Experts (VGE) to consolidate the use of the spectrum by applying flexible generic allocations failed largely due to the efforts of U.S. government users. The FCC, NTIA and State should re-study the work of the VGE. This could provide more flexible use of the allocations domestically, enable the U.S. domestic spectrum to be more inline with international allocations and ease acceptance of U.S, domestic policies overseas. The agencies should not let their constituencies veto change if the opposition is based on fear of change. If there is merit, the U.S. should support a future WRC agenda item on this issue.

28. Are there ways in which the Commission can or should improve the coordination process with Canada and Mexico? If so, how?

The establishment of reliable databases will facilitate coordination.

CONCLUSION

Economists are not experts in radio or radio spectrum. Economic theory albeit it sound in macro-markets is not relevant when applied holus-bolus to the multitude of factors that are intrinsic to individual radio systems and frequency allocations. The market approach has resulted in spotty coverage and uneven quality of PCS service with consumers trapped by one service provider because of incompatible equipment. The original unauctioned cellular systems provide the best coverage.

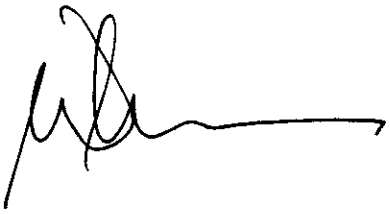
The growing income of mobile operators suggests the public financial gain from spectrum would significantly increase in the longer term from an annual spectrum rent, as a fixed portion of revenue. An universally applied spectrum rent will promote efficient use by all users. Auctions may have demonstrated their efficiency to the government process but they have not clearly demonstrated optimum use or financial valuation of the spectrum and better service, as other options have not been tested.

Government abandons a large part of its fiduciary responsibility for the public spectrum when it applies market solutions. In many ways, auctions are no less onerous than the administrative process that preceded it, only more facile. The strained support found for auctions by operators is because they have no option or because they have the deepest pockets. The government has decided that the only way to obtain certain new spectrum is to pay for it. Opposing this would not serve entrants any useful purpose.

The financial success of past auctions may be an artifact of a rising stock market. Recently, the stock market has decided that it does not like massive expenditures for radio licenses, so these past experiences may not be repeated; if they are, the resulting rollouts of service may be poorer than ever, as capital financing will be harder to find.

The market-oriented experiment should be carried to its conclusion, but there is far too little experience to indicate that it will prove a success in the long term. The scope of application should not be expanded until greater experience is gained. Should the method be expanded and prove flawed, it will be difficult to recover from, as spectrum use will be fragmented and scattered, and rife with deeply vested interests. The U.S. use of the spectrum can drift even farther away from uses in other parts of the world. Attention should not be drawn away from possible improvements to the traditional allocation and assignment methods, which have evolved over decades, or the development of new methods of frequency allocation that may have new assignment opportunities.

Dated this 3rd day of July, 2002



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Annex 1

A Flexible Allocation Process

It is generally accepted that the number of users per unit area is maximized when the interference characteristics (emission type, power, coverage, interference susceptibility) of the radio systems using the frequency or band are the same or very similar. This is a technical reason why the traditional system allocates frequencies (bands) to specific services (e.g. Radionavigation). Another equally if not more important reason to allocate by band is to group users with similar non-technical characteristics (growth, operational, institutional) into cohorts, which reflect similarities in patterns of participant behavior, leading to more harmonious frequency coordination and spectrum planning (e.g. Aeronautical Radionavigation). If the need for competitive planning by users can be reduced or eliminated, it enables consideration of technical allocation by the radio signal characteristics (e. g. pulsed devices) which would well define the band. In this present example, new pulsed radio devices would share the band if they can co-exist, avoiding the need to define new band for a new application or new pulsed radio technology. This is a further refinement of the concept of type of use over type of user.

Many of these new cohort bands would come from bands differentiated on management criteria rather than significant technical differences, and may be already close to the desired result. One immediate benefit should be greater access by all participants to a greater number of frequencies. In time, this would increase spectrum efficiency and growth capacity by giving wider access to less heavily used traditional bands by giving more spectrum choice to each cohort participant. Allocations should become less politicized, as greater cooperation would benefit users who before competed with each other for spectrum. The technical aspects of frequency coordination would see little change, although new channels of communication for inter-system frequency coordination may be needed.

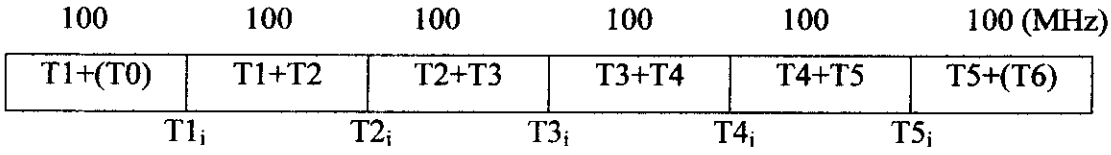
It is further proposed the new bands have flexible boundaries, which would reflect the actual and local demands on spectrum. Overlapping Flexible bands where assignments of, say, Type 2 are started away from the adjacent Types, but allowed to grow into their spectrum, if required, would help alleviate concerns about allocating too much or too little spectrum for a given purpose. If Type 1 growth blocks Type 2 growth, then Type 2 has an opportunity to grow into the other adjacent Type 3 spectrum. Similarly, Types 1 and 3 might grow into their other adjacent spectrum. The bandwidth of the allocations can be more generous than now. Under-used spectrum can be identified for a new use. Success depends on easily retunable equipment.

First-come, first-served frequency assignments are made in a random-like fashion, in that the location and time of the next requested frequency cannot be determined. An analogy is throwing sticks into a woodbox – the random pile is much less space efficient than if the sticks are carefully stacked. When a band becomes congested by conventional assignments, refrequencying can sometimes achieve significant spectrum savings. Re-frequencying to adapt to the re-defined bands would also allow optimization, also justifying easily retunable equipment.

A technically based allocation scheme may enable the introduction of a new service with minimal Commission intervention. If, for example, a new technology emerged that had the same characteristics as DTV, it could be directly inserted into the DTV bands, provided the Commission was satisfied that the Flexible band was adequate to serve the foreseen needs of both. This distancing of the FCC from adjudication of spectrum access would add a great deal to the timely and efficient use of the spectrum.

AN EXAMPLE OF USE OF FLEXIBLE ALLOCATIONS

For the sake of demonstration, five services (T1 through T5) which are each homogenous within themselves are initially distributed across 6 - 100 MHz blocks as shown.



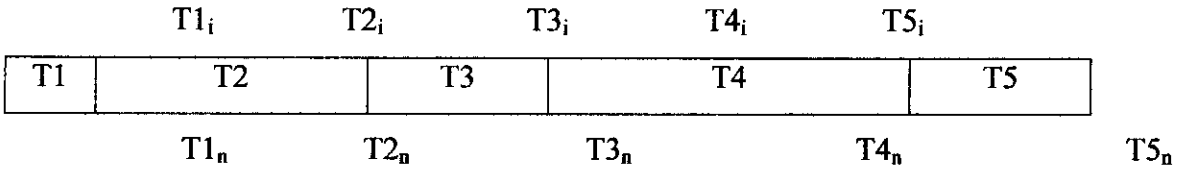
Each service begins initial assignments (Tn_i) at the center of their 200 MHz block. If the two adjacent services did not grow, each has a potential band 200 MHz wide. Over time it is determined that the services are using the spectrum at the following average annual growth rates.

T1	T2	T3	T4	T5
5%	15%	10%	20%	10%

The imputed spectrum requirements for each service at that time are as follows.

T1	T2	T3	T4	T5
50 MHz	150 MHz	100 MHz	200 MHz	100 MHz

The following chart shows the forecast band boundaries based on the current growth rates. New assignments are made around point Tn_n. The initial assignments located around Tn_i are moved toward the new assignment location Tn_n at a convenient time, if required by future growth rates.



Annex 2

EVALUATION OF THREE ALLOCATION METHODS INCLUDING LICENSING ASPECTS

	Traditional	Market	Flexible Allocations*
Government Revenue	Low - Administrative fee recovery only	Variable - First auction revenue, but no revenue from secondary or non-auctions. Amount depends on a large number of factors including capital market temperature	Potentially High – this, and any allocation model will be enhanced by a spectrum rent based on a fixed percentage of revenue, or imputed equivalent charge in non-commercial bands.
Front-end Cost Loading to Operator	Low – license application fee and participation in regulatory process	High – "Successful" auction reduces capital base, which reduces speed and extent of roll-out, and increases user fees.	Low – access to additional spectrum is determined within limits by growth history
Spectrum Flexibility	Moderate. Changes can be time consuming but it is an ongoing process.	Unknown. Although initial allocation may be technology neutral, and relatively fast, future change may be difficult due to implied ownership rights.	High. Band boundaries change with local demand. New applications/ technologies can be introduced without allocation change..
Spectrum Consistency	High. Allocations based on national and international standard uses, easing change and "roaming"	Unknown, but possibly Low. The highest value use will differ in different locations. This will cause "economic allocation drift" and make future consistency changes difficult.	High. Defined by technical compatibility, but would require international adoption for full benefit.
Interference Protection	High. Current allocations based on compatibility and community of interest.	Unknown. Highest value use in adjacent areas may be incompatible. Multiple types of use by auction may give rise to unpredictable harmful interference.	High. Systems in each band are compatible by design. Community of interest changes from type of user to compatible use
Administrative / Political Involvement	High. Process based on satisfying competing user communities and identifying spectrum as such. Process is democratic.	Moderate. Although auction administrative process is simpler, significant administrative and political intervention determines auction criteria. Major adjustments will be very political. Process is elitist (deepest pocket)	Initially High to establish regime, then Low, as identification and aggregation can be objectively determined. Owners/operators can negotiate adjustments without regulator involvement. Ongoing process can be apolitical.

* as described in this paper

Annex 3

AVAILABILITY OF SPECTRUM FOR COMMERCIAL CONSUMER USES

A non-definitive examination of the respective domestic allocation tables in the 1-10 GHz range indicates Canadian industry has nearly twice the amount of spectrum available to U.S. industry for general commercial use. In large part, this is because Canada's spectrum policy reflects type of use rather than type of user. Government and non-government users share more of their spectrum.

Approximate Amount of Available Spectrum in 1-10 GHz

(GHz)

	Government Exclusive	Total Commercial Access	Commercial Exclusive
U.S.	3.1	3	2.2
Canada	0.5	5.6	0

The commercial counts excludes radar, navigation, telemetry, amateur and space science bands, and secondary allocations, which although used by the non-government sector are of narrow, specialized or limited commercial value. Total Commercial Access is the sum of Commercial Exclusive and Shared bands (not shown).

A natural dominance of government use arises for several reasons – the military is an early adopter of new radio technology in higher frequency bands. By the time these advanced techniques become commercially viable, and the FCC is petitioned to provide spectrum, much of it is already in use. Since the authority for spectrum flows from the President, federal government agencies may have an implied if not actual first call on it. Anecdotally, there have

been cases where new military systems used new bands without consultation on the choice of frequency outside of the program office.

The manager of federal spectrum is a government entity like those it manages, which significantly reduces ability to control how spectrum is used. Since government agencies at all levels are driven by limited budgets, it is extremely difficult to modernize equipment for the sake of spectrum efficiency, and because of exclusive government bands, there is a reduced need to do it to compete with commercial users for spectrum. In spite of, or because of it, NTIA deserves the highest grades as it makes meaningful contributions to all sectors in a difficult spectrum planning and management environment.

Immediate improvements in the use of government spectrum would be seen if government agencies were charged a spectrum rent. Reduced spectrum use would save governments money by reducing inventories, and by encouraging participation in bands where commercial activities draw down equipment costs.

Although direct comparisons are not possible, a literature search suggests the FCC has authorized over 13 million assignments, and NTIA less than 500,000.

A GRIM FAIRY TALE

THE GOBLINS AND THE MAGIC LANTERNS

Once upon a time not long ago, in a kingdom not far away, genies who are always inventing new things, discovered magic lanterns that let anyone, anywhere in the world, see and talk with each other, and trade stories and share books. Such great distances were possible because the magic lanterns used a special blue-green light that was reflected from the sky. Unfortunately, this color of light was used since ancient times by goblins for magic candles, which although costly, let the few people who could afford them see each other and talk, and trade stories and share books, but only over small distances such as across the square or the village.

Now the light from a magic lantern must travel many, many miles to the sky and back to cover such great distances, and their light becomes much fainter than the light from a candle, for many miles around the candle. If one could see a candle, one couldn't make out a magic lantern, as the candle would always be too bright. Fortunately, the goblins had been around for a long time, and they had magic candles in many different special colors. It was agreed, against their wishes, that they would stop using the blue-green light, so the common people could use the new magic lanterns, which could not work in any other color.

The King decided this, as he controlled all the colors of the rainbow in the kingdom. His advisors, however, had grown fond of the goblins over the years, and looked with favor on their stories of distress - that they would have to buy brand new candles in other colors to replace those that had not yet burned out, and this would be unfair. The advisors decided that the genies should buy the goblins brand new magic candles. The genies objected, saying that everyone, including the goblins know full well that candles burn out, and the goblins have treasure set aside to replace burned-out candles. This treasure was gained from the taxes of the kingdom, and the high tolls the goblins charged for the use of the candles. The goblins do this so they don't have to borrow gold every time a candle burns out, as borrowing is always an expensive last resort.

But the genies offered to pay for the unused stubs of each blue-green-light candle. They considered this fair, because the laws and ways of the kingdom and treasurers ensured that the cost of the burned part of candles was deposited in the goblins' treasuries, so by the time any candle burned out, the goblins already had enough gold to replace it.

The goblins and advisors rejected this generous offer, and also denied the genies' claim that this decision created a gift of a pot of gold under each blue-green candle stub (magic candles are very expensive), and even if it did, they said that some goblins, who worked for the King or the Princes of states, did not bother to have a separate treasure set aside to replace their candles. These goblins use the King's or Princes' treasures, which always come from taxing the people, to buy their candles. There were also some goblins who did not work for the King who said they had not set aside treasures. Of all of these, many charged the people high tolls for their use of the magic candles, and used their taxes, and yet never set aside gold. This decision would also increase the cost of the genies to make the magic lanterns, which would make them more expensive to the people. In addition, it was very unlikely the goblins would reduce their tolls on the people for the use of these new free candles which use other colors.

The genies rightly said that it was the goblins' choice if they didn't wish to use the laws or follow the ways of the kingdom and treasurers to keep a separate treasure for new candles, but they the genies and the people should not be made to pay for this choice. They thought it was unfair that those who didn't plan ahead should be paid for not doing so, and even more unfair that those who did were also paid.

There was much suspicion that the advisors didn't care that the payment for new candles could be so high that the genies could not afford to build their invention, or if they could, would make the new invention too expensive for most of their sovereign subjects, leaving the goblins in control of seeing and talking across the square and village. The glare of blue-green candles and this expense would certainly keep the common people everywhere from seeing and talking around the world.

The advisors seemed also not to care that in the end the people would doubly or trebly pay the goblins for their candles, or that other kingdoms would use their decision to demand that even larger pots of gold be placed under their candle stubs. They said that large pots of gold are a prudent way to manage the colors of the rainbow, even though it might make the cost of good,

new inventions too high by rewarding old, replaceable inventions, beyond their real value. They also fooled a judge into believing this was right.

Justice is hard to find even in a just Kingdom, so it is important to correct injustice when it is found. When this injustice is made right, the advisors and the goblins will not play this trick again, and the genies and the common people can live happily ever after. And so will the goblins.

THE END